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# The neutron star in HESS? J1731 - 347: Central compact objects as laboratories to study the equation of state of superdense matter

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## Abstract

© ESO, 2014. Context. Central compact objects (CCOs) in supernova remnants are isolated thermally emitting neutron stars (NSs). They are most probably characterized by a magnetic field strength that is roughly two orders of magnitude lower than that of most of the radio and accreting pulsars. The thermal emission of CCOs can be modeled to obtain constraints on the physical parameters of the star such as its mass, radius, effective temperature, and chemical composition. Aims. The CCO in HESS? J1731-347 is one of the brightest objects in this class. Starting from 2007, it was observed several times with different X-ray satellites. Here we present our analysis of two new XMM-Newton observations of the source performed in 2013 which increase the total exposure time of the data available for spectral analysis by a factor of about five compared to the analyses presented before. Methods. We use our numerical spectral models for carbon and hydrogen atmospheres to fit the spectrum of the CCO. From our fits, we derive constraints on the physical parameters of the emitting star such as its mass, radius, distance, and effective temperature. We also use the new data to derive new upper limits on the source pulsations and to confirm the absence of a long-term flux and spectral variability. Results. The analysis shows that atmosphere models are clearly preferred by the fit over the blackbody spectral function. Under the assumption that the X-ray emission is uniformly produced by the entire star surface (supported by the lack of pulsations), hydrogen atmosphere models lead to uncomfortably large distances of the CCO, above 7-8? kpc. On the other hand, the carbon atmosphere model formally excludes distances above 5-6? kpc and is compatible with the source located in the Scutum-Crux (~3? kpc) or Norma-Cygnus (~4.5? kpc) Galactic spiral arm. We provide and discuss the corresponding confidence contours in the NS mass-radius plane. The measured effective temperature indicates that the NS is exceptionally hot for the estimated age of ~30? kyr. We discuss possible cooling scenarios to explain this property, as well as possible additional constraints on the star mass and radius from cooling theory.

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## Keywords

Stars: atmospheres, Stars: neutron